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# USSR Report

## ENGINEERING AND EQUIPMENT

(FOUO 5/80)

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# USSR REPORT

## ENGINEERING AND EQUIPMENT

(FOUO 5/80)

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CONTENTS (Continued)

MECHANICS OF SOLIDS

MARINE AND SHIPBUILDING

## ELEMENTARY THEORY OF SUBMARINES

Moscow ELEMENTARNAYA TEORIYA PODVODNOY LODKI (Elementary Theory of Submarines) in Russian 1977 signed to press 26 Oct 77 p 2-4, 133-134

[Annotation, introduction and table of contents from book by Yuriy Ivanovich Bol'shakov, Voyenizdat, 23,000 copies, 136 pages]

[Text] This book sets forth, in a popular fashion, the relation of buoyancy to the size and shape of a submarine, the change in buoyancy during submersion, surfacing and floating under water, the change in stability during submersion and surfacing, during shifting of cargo, settling on the bottom, docking and running aground, the unsinkability of submarines above water and under water, and calculation of ballast trim. The book is intended for the self-instruction of submarine personnel. It can be used as a textbook for Naval instructional detachments.

### Introduction

Submarines, in order to carry out their assigned tasks, must have completely well-defined qualities. The so-called seaworthy features of submarines occupy an important place among them: buoyancy, stability, unsinkability, propulsive performance, controllability, and rolling. Submarine theory is the science of its seagoing qualities. Knowledge of submarine theory enables submarine experts to predict the behavior of a submarine in various floating conditions, to make maximum use of its seagoing qualities, and to take the necessary measures to prevent defects.

Each crew member of a submarine must efficiently and professionally perform his duties, work skillfully while water is entering the vessel's hull, strictly observe weight requirements, be aware of the harmful effect of excessive cargo, of a change in ballast trim of the submarine during its submersion and surfacing, and also of a decrease in stability during submarine docking or bottoming.

Submarine specialists, who are directly responsible for the effective utilization of the fast, maneuvering features of a vessel, for maintaining its proper acoustical characteristics, for ballast trim and assurance of stability and unsinkability of the submarine, must know perfectly the theory of submarines. The rapid and sophisticated solution of an entire set of problems under varying navigating conditions depends on skillful guidance based on knowledge of submarine theory and experience of the submarine specialists. Without a deep understanding on the part of submarine specialists of such seagoing qualities as navigability and the principles for operation of propellers, efficient utilization of the submarine power plant is impossible, and for precise fulfillment of different submarine maneuvers one must be well-versed in aspects of its controllability.

Development of the theory of submarines is closely related to development of ship construction. Academician A. N. Krylov has played an important role in the history of Soviet ship construction and development of ship theory. The famous scientist and shipbuilder I. G. Bubnov did much for the practical improvement of the seagoing features of submarines. The service of Soviet scientists, designers and Naval officers in the creation and development of modern submarine theory is very great. Such scientists and ship engineers as V. G. Vlasov, P. G. Goinkis, D. L. Garmashov, K. F. Ignat'yev, S. V. Kozlov, B. M. Malinin, N. Ya. Mal'tsev, P. F. Papkovich, E. E. Papmel', D. P. Skobov, G. G. Sallus, K. K. Fedyayevskiy, Yu. A. Shimanskiy, A. N. Shcheglov and others have made important contributions to the development of submarine theory.

In improving the combat and seagoing features of modern submarines, Soviet scientists and designers promote all-out growth of the power of our submarine fleet.

Our submarine crews, in carrying out their duty to their Motherland, are mastering modern, complex combat techniques, are improving their skills and are increasing their professionalism. This book is intended to help them in this matter.

In this book an attempt is made for the first time to set forth in an elementary fashion submarine theory, taking into consideration the requirements of the Unified System of Design Documentation and the International System of Units (SI) and other standards documents. Therefore, it was considered wise to use new designations and forms of tables. In some cases the author thought it possible to preserve the symbols and designations traditionally used in submarine theory, although they do not conform to standard documents.

The author is firmly of the opinion that graphics and clear exposition are more important for Naval personnel than mathematical correctness. Therefore, in a number of cases, strictness of demonstrations gave way to graphic description and clearness of presentation of the problem. The author expresses his deep indebtedness to Rear-Adm. R. D. Filonovich, Rear-Adm S. S. Ivanov, Engr-Capts 1 st rank N. N. Yefim'yev and V. K. Tokmakov for their careful examination of the manuscript and their ever valuable criticism and advice, and he also sincerely thanks the honored worker of the RSFSR Engr-Capts 1 st rank Ye. P. Shikanov for his direct help in setting forth submarine theory from the position of modern requirements.

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NUCLEAR ENERGY

UDC 621.039.56

OPERATING MODES OF WATER-COOLED, WATER-MODERATED NUCLEAR POWER REACTORS

Moscow EKSPLUATATSIONNYYE REZHIMY VODO-VODYANYKH ENERGETICHES-KIKH YADERNYKH REAKTOROV in Russian 1979 pp 3, 287-288

[Foreword and table of contents from the book "Ekspluatatsionnyye Rezhimy Vodo-Vodyanykh Energeticheskikh Yadernykh Reaktorov" by Fedor Yakovlevich Ovchinnikov, Lev Ivanovich Golubev, Vyacheslav Dmitriyevich Dobrynin, Viktor Ivanovich Klochkov, Vladimir Vladimirovich Semenov and Valentin Mikhaylovich Tsybenko, Izdatel'stvo Atomizdat, Moscow, 2d edition, signed to press 3 July 1979, 4,100 copies, 288 pages]

[Text] FOREWORD

The program for the development of nuclear power engineering in the USSR provides for the construction of a large number of AES's in which the thermal energy source is a water-cooled, water-moderated power reactor (VVER). In connection with this, the correlation of information obtained during the operation of VVER's have been partially touched upon in the book "Ekspluatatsiya Reaktornykh Ustanovok Novovoronezhskoy AES" ("Operation of Reactor Units at the Novovoronezhskaya AES"), which was written by F. Ya. Ovchinnikov and others and published by Atomizdat in 1972.

In this book the basic attention is focused on a discussion of the operating modes of VVER's.

In it we explain the principles of the neutron-physics, thermohydraulic and physicochemical processes taking place in a VVER and also systematize and correlate Soviet and foreign data on the operating modes of reactors of this type. The authors base their discussion of methods for the theoretical prediction of the basic neutron-physics and thermohydraulic characteristics of VVER's on the pertinent developments made at the Institute of Atomic Energy imeni I.V. Kurchatov under the leadership of Doctor of Technical Sciences V. A. Sidorenko, Candidate of Technical Sciences G. L. Lunin, Candidate of Technical Sciences A. N. Novikov, V.A. Voznesenskiy and others. The examples used in the explanation of the operating modes are the Soviet VVER-440 and VVER-1000 reactors from Unit 5 at the Novovoronezhskaya AES.

The sections that are basically concerned with the VVER-1000 have been reworked and added to for this second edition. The other of the explanation of these materials has been changed and a number of refinements and corrections have been introduced. In the authors' opinion, this book can serve as a textbook for the training or specialization of AES engineering and technical personnel working both on the operational exploitation of VVER-type reactors and their different systems, and in laboratories with the appropriate profiles. It is also useful to students with power engineering, physicotechnical and engineering physics specialities in VUZ's and those attending power engineering tekhnikums.

The authors wish to express their gratitude to Doctor of Technical Sciences S.A. Skvortsov for the council he provided when this book was being reviewed.

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OUTLOOK FOR DEVELOPING A NUCLEAR SINGLE-LOOP HELIUM TURBINE SYSTEM WITH A HIGH-TEMPERATURE REACTOR OF ONE MILLION kWe POWER

Moscow ENERGOMASHINOSTROYENIYE in Russian No 2, Feb 80 p 45

[Text] At a joint meeting of the section of nuclear machine building, gas turbines and compressors [of the Scientific and Technical Council of the USSR Ministry of Power Machinery] reports were considered on the prospects for developing power units in nuclear electric plants with single-loop helium turbine facilities and high-temperature reactors [HTGR] with unit power of one million kWe or more. An analysis of non-Soviet material has demonstrated the feasibility of producing helium-cooled high-temperature nuclear reactors in the near future with pre-stressed ferroconcrete enclosures having a power of 2000-3000 MWt with helium parameters of up to 1000°C and 5-8 MPa at the output.

Over the past ten years in the Soviet Union and other industrially developed countries, experimental industrial research has been in progress on developing power facilities with HTGR reactors and single-loop helium turbine facilities. In West Germany, an experimental facility with an AVR reactor has been in operation on which a stable helium temperature of 950°C has been achieved at the reactor output, and a helium gas turbine installation is in operation in Oberhausen with a non-nuclear heat source. This facility has a power of 27 MW.

The most suitable type of reactor for a nuclear gas turbine facility is a thermal reactor with spherical fuel elements and one-time passage of the thermal neutrons through the core. This gives a helium temperature of 850-950°C at the reactor output and high volumetric density of the heat flux in the core at permissible temperatures of the ceramic nuclear fuel. At such helium parameters, the most effective power plant is either a single-loop gas turbine facility in which the working fluid is the helium coolant, or a combined helium-steam plant. When the helium temperature at the inlet to the gas turbine facility is of the order of 950°C, an efficiency of at least 45% can be achieved, i. e. 1.5 times as high as in conventional nuclear power plants with water-water reactors, and the the fuel component of electric power production can be considerably reduced.

With this arrangement, an integrated configuration of the entire complex of helium gas turbine facilities is possible with accommodation in cavities formed in the prestressed ferroconcrete enclosure, resulting in improved nuclear safety and operational reliability, and a reduction in the cost of an installed kilowatt-hour of nuclear electric plant power by 10-15% as compared with HTGR facilities with two-loop steam-turbine plants. According to specifications for ensuring nuclear safety of the plant, there should be at least two helium turbogroups, which means that each should have a minimum power of about 500 MWe. The optimum design for the nuclear gas turbine facility is as follows: a single-shaft facility with horizontal shaft placement, speed of 3000 rpm, intermediate cooling of helium with compression and degree of heat regeneration of 90%.

An appreciable enhancement of the efficiency of the nuclear electric plant (3-5%) with gas turbine facility can be achieved by using a gas turbine facility of the simplest cycle in the steam-gas unit, with generation of electric power both in a generator of the gas turbine plant, and in a generatorless steam-turbine facility.

The choice of the fundamental scheme of the nuclear electric plant with HTGR and nuclear gas turbine facility must be made with consideration of technical-economic indices of different modifications by specialists in the field of reactor design and gas-turbine construction. The results of present-day studies show that impurities in helium affect reactor and gas turbine materials. At a temperature of less than 600°C, helium has little effect on these materials, but serious research will be needed in the field of alloys based on molybdenum and niobium to reach a temperature of 1000°C. Research is being done on materials and technology for getting the necessary parameters of nuclear gas turbine plants, and the results can be used for the engineering design.

In nuclear facilities with HTGR and nuclear gas turbine facilities, a dry cooling tower can be used with reduced flowrate of circulation water, and also takeoff of heat from the heat exchangers for district heating purposes, all of which is conducive to a further improvement of economy.

The development of such facilities is preceded by a complex of experimental and developmental research on the HTGR and helium turbine plants: construction and elaboration of experimental facilities with HTGR and full-scale helium turbine facility with a non-nuclear heat source, research on developing materials for helium turbines and the like.

Based on the reports that were heard and on the discussion of the joint session, it has been recommended that with consideration of the benefit to be realized by the national economy of the nation as a result of improving the economic and ecological indices of nuclear electric plants, and taking account of the considerable technical and organizational complexities of solving this problem, more research should be done on

closed-cycle gas turbine facilities using helium with HTGR reactors with unit power of a million or more kilowatts, with helium temperature at the reactor outlet of 850-950°C. It is advisable to begin work on a helium gas turbine plant with development of a full-scale model of an experimental single-shaft gas turbine facility, testing it at reduced pressure with conventional [non-nuclear] heating of the helium on a stand with horizontal shaft at 3000 rpm.
[8144/0983-6610]



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NON-NUCLEAR ENERGY

UDC [621.181:628.165]:629.12

STEAM-GENERATING UNITS OPERATING ON SEA WATER

Leningrad PAROGENERATORNYYE USTANOVKI NA MORSKOY VODE in Russian 1979
pp 2, 230-232

[Foreword and table of contents from the book "Parogeneratornyye Ustanovki na Morskoy Vode" by Leonid Illarionovich Sen' and Yuriy Vladimirovich Yakubovskiy, Izdatel'stvo Sudostroyeniye, Leningrad, 1979, signed to press 13 June 1979, 3,700 copies, 232 pages]

[Text] FOREWORD

The development of heat- and power-engineering units must proceed along the line of reducing the effect of production technology on the environment and increasing their economic effectiveness. At the present time the analysis of power-engineering units is, as a rule, limited to a discussion of the thermal efficiency of equipment and machinery without taking into consideration the nature of the output, the amount of water consumed, and the pollutants released into the atmosphere.

However, as a result of the increase in the amount of water consumed during the production process, some approach to the question of using sea water is required. In particular, it is advisable to develop new units that are capable of operating on polluted or sea water. Under conditions of limited natural fresh water sources, such units should insure the production of fresh water in a quantity sufficient for technological requirements without increasing fuel consumption.

There is almost no literature on planning and designing elements of power-engineering units operating on sea water, and this book is the first attempt to develop techniques for designing the thermal systems of steam-generating and recovery units that operate with sea water.

L. I. Sen' wrote Section 1.1, Chapter 2, Sections 3.3-3.5, 4.2, 5.5-5.8, 6.2-6.5 and the appendices; Yu.V. Yakubovskiy wrote Sections 1.2-1.6, 5.1-5.4 and 6.1; L.I. Sen' and Yu.V. Yakubovsky, together with V.V. Permyakov, wrote Sections 3.1 and 3.2; L.I. Sen' and V.G. Dobrozhanskiy wrote Sections 4.1, 4.3 and 4.4. L.I. Sen' was responsible for the overall editing of the manuscript.

The authors wish to express their heartfelt thanks and gratitude to Professor A.M. Podsushnyy for a number of valuable methodological instructions in the preparation of this book, and Professor N.V. Golubev for his critical remarks and recommendations on selecting materials for it.

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SYSTEM FOR THE OVERALL AUTOMATION OF COMPRESSOR STATIONS

Moscow PROMYSHLENNAYA ENERGETIKA in Russian No 10, 1979 pp 31-33

BOGOSLOVSKIY, YU. S., SHAYKHUTDINOV, G. G. and VERBITSKIY, A. M.,
State Institute for the Design and Planning of Mine Construction in the Southern Regions of the USSR

[Abstract] The recently developed UKAS system for the turbocompressors in the K100-K500 series manufactured by the Khabarovsk Energomash Plant represents a highly effective and reliable automation package which produces considerable savings by replacing relay-contact equipment with its contactless counterparts, incorporating more sophisticated design features, and assuring more extensive control and monitoring of compressor-station facilities. The system is based on programmed control of the parallel-connected operating cycle of a multiple-unit compressor station. It assures a turbocompressor start-up time of 30 minutes underload. A block diagram of the system is presented. The UKAS package consists of two sub-packages: UKAS-A (ShKh-9102-53A3 type control bay, a ShES-9006-00A2 type control panel section and a process monitoring panel, delivered by the Energomash Plant in tandem with series K100-K500 compressors); and UKAS-5 (ShES-9103-83A3 type auxiliary drive bay and ShES-8801-0SA3 monitoring bay, also delivered by the Energomash). Figure 1.
[22-1386]

## MECHANICS OF SOLIDS

UDC 625.03

### VIBRATION AND THE STRENGTH AND STABILITY OF COMPLEX MECHANICAL SYSTEMS

Kiev KOLEBANIYA, PROCHNOST' I USTOYCHIVOST' SLOZHNYKH MEKHANICHESKIKH SISTEM in Russian 1979 pp 2, 155-156

[Annotation and table of contents from the collection of works "Kolebaniya, Prochnost' i Ustoychivost' Slozhnykh Mekhanicheskikh Sistem," edited by L. Ye. Borodyanskiy and T.V. Katsovenko, Dnepropetrovsk Department, Institute of Mechanics, Ukrainian SSR Academy of Sciences, Izdatel'stvo Naukova Dumka, Kiev, 1979, signed to press 4 April 1979, 1,550 copies, 163 pages]

[Text] ANNOTATION

The articles in this collection are based on the results of theoretical and experimental research on the dynamics and strength of complex linear and nonlinear mechanical systems. In a number of articles the authors explain methods for solving the problems involved in optimizing the parameters of dynamic systems and identifying them. In many cases the research has been done with due consideration for the random nature of actual external influences. Steady-state and transient motion modes, including those influenced by short-term effects, are analyzed.

This book is intended for scientific, engineering and technical workers concerned with problems of applied mechanics, machine building and transportation.

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